fore, be classified as those which can be referred to an 'atomic' factor, and those which possess a 'mass' factor. The former are in the majority. And the periodic law is the bridge between them; as yet, an imperfect connection. For the atomic factors, arranged in the order of their masses, display only a partial regularity. It is undoubtedly one of the main problems of physics and chemistry to solve this mystery. What the solution will be is beyond my power of prophecy; whether it is to be found in the influence of some circumstance on the atomic weights, hitherto regarded as among the most certain 'constants of Nature,' or whether it will turn out that mass and gravitational attraction are influenced by temperature, or by electrical charge, I cannot tell. But that some means will ultimately be found of reconciling these apparent discrepancies, I firmly believe. Such a reconciliation is necessary, whatever view be taken of the nature of the universe and of its mode of action; whatever units we may choose to regard as fundamental among those which lie at our disposal.

In this address I have endeavored to fulfill my promise to combine a little history, a little actuality and a little prophecy. The history belongs to the Old World; I have endeavored to share passing events with the New; and I will ask you to join with me in the hope that much of the prophecy may meet with its fulfilment on this side of the ocean.

WILLIAM RAMSAY.

ADDRESS BY THE PRESIDENT BEFORE THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

IN opening the proceedings of this fourth annual meeting of the Society for the Promotion of Engineering Education I wish, first of all, to congratulate the Society upon its great success thus far in accomplishing the object for which it was founded, an object fully expressed in its name. The volumes of its proceedings already published are filled with discussions and the ripe conclusions of the best thought that can be expressed to-day upon many phases of engineering education. No one who desires to become informed upon these matters can afford to neglect these volumes. It is believed that all interested in the object of our Society will find it to their advantage to unite with us.

One striking peculiarity of engineering education seems to me to lie in the fact that it has been determined so largely as to its scope and the lines of its development by the engineering colleges themselves in advance of the formulated demands of the engineering profession and of the public in general, and often, indeed, in opposition to such demands. Through the wisdom and foresight of these organizers of engineering education the profession of engineering has come forth during this generation into public estimation as a learned and responsible profession, quite the peer of law or medicine. This is the work of the engineering colleges, and from the deliberations of this Society it is evident that they still have a large work before them. The educational institutions of our country are in a state of flux. The present movement in education is powerful. These times will be looked back to in future days as those in which mighty educational forces were inaugurated and were adapted to the needs of the nation just as it was coming to its full consciousness as one of the great family of nations, a consciousness of power and responsibility that is causing it to depart somewhat from the revered advice of Washington, which was to keep aloof from European affairs and entanglements with other nations of the earth and work out its own destiny by itself. National growth and our multiplied facilities for communication have greatly modi-

fied our feeling as to this. The triumphs of the engineer in applying steam and electricity are making of one blood all nations of the earth. But the one thing that is making and will make of us a nation worthy of our heritage is our educational life. Our republican institutions, the pride of our early national life, cannot continue such except for the reinforcement and help to come from the enlarged scope of education to-day.

It has seemed to me that I could not, perhaps, use the short time allotted to me for this address better than in trying to summarize some of the thoughts which have appeared in the papers and discussions before this Society, which had its beginning in the Engineering Congress of the Columbian Exposition at Chicago. What I have to say is called forth by the enlarged responsibilities and new conception of the professional position of the engineer of to-day, and the course of study necessary to fit him for the responsibilities of his position.

And, first of all, I think I am right in saying that the demand is growing stronger that courses of engineering instruction shall include nothing else, that is, that they shall be as completely professional in their character as are professional courses in law and medicine.

This demand is not made by the general public, nor to any great extent, I think, by practicioners in the engineering profession. These are greatly impressed with the necessity the engineer has for general culture, and rightly so. The demand is one made by the engineering colleges themselves. At present the curriculum of our average engineering college includes from 20 to 25 per cent. of culture studies, such as English, French and German; from 30 to 25 per cent. of indirectly technical study, as Mathematics, Physics, etc.; and 50 per cent. of directly technical study.

The culture studies are of fundamental importance to the engineer. He usually obtains far too small an amount of such study before graduation. He finds himself poorly fitted in this respect for his subsequent career. His preparation in the use of language for writing and speaking has been too meager. He finds that his professional work is not of a character to supplement his education in this particular. Yet culture studies are out of place in any engineering course with strongly marked technical tendencies. Both student and instructor feel this. The two kinds of study interfere with each other. The student cannot fix his attention on culture study while absorbed in the beginnings of technical study. The instructor in the culture studies feels the hopelessness of the task and must perforce be content with a lifeless, memoriter fulfilment of task work. The instructors in the technical studies are apt to be impatient at the time and attention demanded by the culture studies as more or less of an obstacle and hindrance to what is rightly regarded as the student's main work.

Under such circumstances as these it seems clear that the culture studies must soon disappear from our engineering courses. This change will, doubtless, come about gradually and will occur in the more fully developed courses first. It will not mean that culture studies shall be omitted from the education of the engineer. It will simply mean that he must obtain them outside of the engineering course, preferably before he enters it. The tendency, on every hand, is to insist more strongly than heretofore upon the culture studies as essential to the engineer. To insure large success he must be a man of broad culture. He is to direct large enterprises as well as plan the necessary structure and machinery of the plant, and that man will succeed who by the influence of his personality, with

tongue and pen, shows himself able to hold his position as the peer of other great organizers of our industrial life. The highest success is to be quickly reached as a rule only by those engineers who have had adequate preliminary education in culture studies, which is another name for the liberal arts. Such culture is now most readily and suitably attained by pursuing some part, more or less complete, of a regular college course. This will come to be regarded more and more as the best preparation for a professional course in engineering, as it is now for a professional course in law and medicine.

Following the consideration of the culture studies comes that of the indirectly technical studies, such as mathematics, mechanics, physics, chemistry and drawing, which at the present time occupy between one-third and one-fourth of the time of the average engineering course. These studies rightfully have place in the course, but the question whether the amount and quality of the work at present accomplished is entirely satisfactory is one which has been much debated. It may be said fairly, I think, that the standard of work in mathematics, mechanics and physics has been gradually but surely advancing in all the engineering colleges, against the opposition of a large part of those engaged in engineering practice, who have been largely opposed to teaching more mathematics, etc., than they themselves were taught, saying that they have had no use for much of that which was taught them. This argument has seemed perfectly conclusive to those who have advanced it, and also to the student, who naturally finds such studies hard, and (as he thinks) much in the way of his rapidly advancing to purely technical study. This view has also often met acceptance with the technical professors, who are largely in sympathy with those engaged in practice. But the argument is fallacious, as I am convinced. The contrary view has prevailed in the papers before this Society. We are to look upon this gradual advance of the standard in mathematics, etc., as a movement which has not as yet ceased, but one still in progress.

Perhaps the point of greatest difficulty, so far as mathematics is concerned, has been to have the differential and integral calculus so incorporated into the engineering courses as to really become part of the working equipment of the student. That may not have been completely accomplished as yet, but that is the standard now regarded as essential, and one which is more and more nearly attained year by year. It is my opinion that it will not be satisfactorily reached until the course in calculus includes the treatment of differential equations. This conclusion is forced upon me, not merely by the abstract consideration that physical and mechanical questions find their expression best by the use of differential equations; but the problems arising just now in the theory of alternating currents must evidently be treated on the basis of their differential equations. Heretofore it has been possible to satisfy the student as to the treatment and solution of the mechanical and physical problems in his course without special study of differential equations, though he was likely to meet a number of points that were puzzling and unsatisfactory by reason of his ignorance of that subject. But now the matter can no longer be avoided, I think, as no other treatment can give the necessary insight into the complicated phenomena which must be fully mastered to-day by the student in electricity.

Mechanics, too, and physics have taken on a larger and larger significance. The principles of mechanics underlie all physical phenomena and all engineering processes. Their formal study has been found to be of increasing importance in under-

standing the strength and resistance of materials, the thermodynamics of steam- and gas-engines, turbines, electrical generators, motors and transformers.

As to physics and chemistry it is unnecessary for me to explain how small are the opportunities compared with what is desirable. The state of knowledge in these sciences is steadily advancing. Hertz waves and Röntgen rays are meeting technical applications, and new knowledge must have place. The field constantly increases. More time must be taken for such subjects. We cannot escape it. It seems impracticable to secure it by having more physics and chemistry taught in the preparatory schools. Such work is not satisfactory. It is preferable to relegate more of the pure mathematics to those schools.

We are to look in the future, as I think, for an increase in the amount and an improvement in the quality of the work in all that part of the work in our engineering courses, which, though but indirectly technical, affords the theoretical basis of the strictly technical studies of the course.

The improvement in the quality of the instruction will lie, for one thing, along the line of the illustrations and problems employed, in seeing to it that they have to do with things tangible and in the direction of practice. This will help secure the necessary interest in theory and make it, as it should be, the basis of practice.

We now come to the consideration of those studies which are strictly and directly technical. They occupy in most engineering courses at least one half of the course. The improvements which have taken place in engineering courses have occurred more largely in this part of the work than elsewhere, but great divergence of opinion has naturally arisen as to what is best. In certain courses of mechanical engineering an excessive amount of manual training and shop work was at first introduced; inexpert opinion still lays undue emphasis upon this part of the course in mechanical and electrical engineering. But as the true function of manual training and trades schools comes to be better understood, and their value to the community in developing handicraft and in furnishing education to the artisan as distinguished from the professional engineer, not only will such schools be well supported and greatly increased in number, but they will be sharply distinguished in the minds of all from the engineering colleges. These last are not intended to make skilled workmen, though some seem still to think so. The engineering student needs a comparatively small amount of practice in wood working, which shall be especially directed toward pattern making; a short experience in the blacksmith shop and foundry, and somewhat more of metal working by hand and machine tools, together with the management of boilers and steam engines. But any effort to make prolonged exercises in these subjects take the place of more theoretical study in an endeavor to make a workman or a foreman instead of an engineer.

The same is true of extended civil engineering field practice with instruments. It is quite possible to put too great emphasis upon it and consume more time with it than the study warrants. The temptation to do that is strong. It must be remembered, however, that surveying is not today the principal occupation of most engineers. The plan of putting shop practice, field work and other like practical parts of the course into the long vacations has much in its favor and seems to be coming more into vogue. The student should graduate from the shop and the surveying corps as soon as he has obtained a moderately good acquaintance with tools and processes and enter the testing laboratory. That is the true field for extended practical work in

the engineering course. In it the work should be arranged with regular sets of graded exercises covering the measurement, proper records and working out the results of tests on all the materials and processes treated in the theoretical work of the student as well as whatever he is likely to encounter in practice or inspection. It is only by prolonged drill in testing that he can acquire the necessary basis for that professional and practical judgment which will make his opinion of value. While thus insisting on testing laboratories as the best and most important recent development of our engineering colleges as well as one of the most costly parts of them, it is needful to insist at the same time and with still greater emphasis on the paramount importance of the theoretic instruction in the mathematical, mechanical and scientific principles which should furnish the core of every engineering course. This it is which engineering colleges must teach and trades schools may entirely omit. Engineering colleges may leave out shops and laboratories, and some do so; they may omit culture studies, and have very imperfect instruction in drawing and design, without forfeiting the claim to give engineering courses of considerable value; but no engineering college can afford, at the risk of imperilling its reputation and usefulness, to neglect or slight, for any length of time, to put forth its best efforts to thoroughly indoctrinate its students in as complete and extended a theoretical treatment of the engineering subjects it teaches as the time at its disposal and the preparation of its students will permit. Drawing and designing, shop practice and testing, general culture and professional information, all are subsidiary and auxiliary to this one thing. Engineering courses at first began with little else in them of importance to the profession than this, and by it they have proved themselves indispensable to it. It is a mistake too frequently made by practitioners, deeply immersed in the details of their profession, to suppose that the most important and fruitful field of instruction is not just here.

Practice, experience, judgment will come in time to the young engineer even if he should not have it before graduation, but study and theory he will not usually thus attain to. That must be had before graduation or the engineering college has little excuse for existence.

This being granted, the fact still remains that the ultimate success of the engineer as a professional man depends upon his character and force as a man among men, upon his culture, upon his integrity, upon his tact and social power. In other professions such qualities receive continuous culture in the practice of the profession. It is far less so with the engineer. Here, then, is an argument for broad preliminary culture before entering upon engineering study, but it likewise points to something with which the engineering colleges have thus far not busied themselves to any appreciable extent, but which in the future cannot be neglected in justice to the position which the profession is called to occupy. Every engineering student has the right to careful instruction in a recognized code of professional ethics which shall instruct his conscience and fortify his will, and give him a satisfying consciousness of duty done to his professional brethren, to the public and to the judge of all the earth.

Until such instruction shall take its place in our engineering courses the public can never rely upon organized professional opinion to restrain unprofessional conduct, nor can individual members of the profession be sustained in courses of right action against the demands of corporations and combinations of capital. It remains, then, for engineering colleges to help organize the profession and to furnish the basis of such

organization in a code of professional ethics which shall be worthy, unifying and elevating.

One step further in this direction is also of importance, namely: Provision for such instruction in the law of contracts as will enable the engineer to discharge with confidence his professional obligations and protect the interests of his employers. For, it is not only necessary that he should have the scientific and technical knowledge to adapt the forces of nature to the projects in view, and exercise good judgment as to the best means of doing this, as well as have the ability fully and clearly to set forth his plans in a manner to carry conviction to those seeking his services; but it is also equally necessary that when entrusted with the responsibilities of actual construction he should be able so clearly and explicitly to set forth the rights and obligations of all parties, that disputes and legal difficulties may not arise, such as often are more costly and troublesome than errors of design. The place to obtain the necessary legal knowledge of specifications and contracts is during the professional engineering course.

It has been urged by some that economic design, as dependent upon the market price of materials, labor and power, should also find place in the engineering course, but the consensus of best opinion seems to draw the line here between education and practice. While the attention of the student should undoubtedly be drawn briefly, yet pointedly, to the economic limitations under which commercial work is done, the attempt to make designs under such limitations should be mostly left to the time when judgment has ripened and the complex conditions of practice are better known by experience. In fact, almost no undergraduate work can usefully reproduce competitive conditions, and the attempt to do this must usually be regarded with distrust. The aim of teaching is not an object lesson under business conditions, but thorough instruction in underlying principles, especially those theoretical and scientific principles which cannot be correctly estimated by the layman.

It will be noticed, in all the matters in which I have attempted to reflect the opinions which are current in the papers that have been presented to this Society and published in its proceedings, the movement and tendencies which I have sketched can be traced, all of them, to a single source, namely, to the position of influence and responsibility which the professional engineer has but recently come to occupy. That position is what it is to-day in the esteem and respect of the public largely through the wise efforts of the managers and instructors of the engineering colleges. Their work in moulding and directing the engineering education in the future will, I am persuaded, be no less important than in the past. That such guidance shall continue to be wise, its progress healthful, and costly mistakes be avoided, will be materially assisted by the deliberations and discussions of this Society.

The valuable report of the committee on entrance requirements, now in your hands, is an important piece of work, taking rank beside the other great educational reports upon the various phases of secondary education which have attracted such general attention during a few years past and have influenced so greatly the work of the preparatory schools as well as the requirements of the colleges.

I regard it as a happy omen that we are met to hold this meeting so early in our history here in Toronto, thereby expressing our interest in the promotion of engineering education as a branch of applied science, confined by no geographical boundaries or limitations, as well as our conviction that some of the most vital elements of human

progress will be moulded by the conclusions we shall reach. Let us address ourselves to the work before us with the same fraternal zeal that has characterized the meetings of the Society in the past, and that in fact is singularly characteristic of that noble body of men who practice the profession of engineering, a profession whose triumphs are our pride and whose future greatness it is the object of this Society to foster.

Henry T. Eddy.
University of Minnesota.

ANTHROPOLOGY AT THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The section was organized August 9th, as follows: W J McGee, Chairman; Anita Newcomb McGee, M. D., Secretary (elected to fill the vacancy caused by the resignation of Harlan I. Smith); W. H. Holmes, Councillor; Alice C. Fletcher (*ex officio*), M. H. Saville, Frank Hamilton Cushing and Warren K. Moorehead, Sectional Committee-at-Large; Washington Matthews, General Nominating Committee; Lightner Witmer, Stephen D. Peet and Alois Hrdlicka, Nominating Committee-at-Large.

The meetings of the section were held in the most spacious of the class-rooms in the high school building, and were well attended not only by members of the Association, but by citizens of Detroit; the attendance ranged from 50 to 400, averaging fully 200. Special interest attached to the afternoon session of August 11th, which was a joint meeting of Sections E and H, in the room assigned to the latter, for discussion of the human relics from sand deposits in Delaware valley. A number of foreign guests, members of the British Association, attended this and other meetings of the section; among them were Dr. and Mrs. Robert Munro, of Edinburgh; Professor and Mrs. J. L. Myres, of Oxford; Prince Krapotkin, of Russia, latterly of Kent, England; Dr. Albrecht Penck, of Vienna; Professor Vernon Harcourt, of Oxford, and Dr. H. P. Truell, of Wicklow, Ireland.

The afternoon of August 9th was devoted to the Vice-Presidential address, which has appeared in this Journal; and the morning session of August 10th was devoted mainly to a summary and continuation of the address, followed by a general discussion of the anthropologic classification suggested therein, in which Miss Fletcher, Dr. Munro, Professor Myres, Dr. Peet, Professor Witmer and others participated. Later a report was presented by Miss Fletcher on the Winter Conference of members of Section H held in New York last December. The section then voted to request authority from the Council to hold a formal meeting at Ithaca during the Christmas holidays of this year. (This meeting was duly authorized by the Council, and a small appropriation was made to cover cost of printing announcements, etc.)

The reading of the papers began with the afternoon session of August 10th. The first of these was an elaborate account of the superstitions, beliefs and practices of the ancient Mexicans, by Zelia Nuttall, read, in the absence of the author, by Dr. Saville. The material was mainly compiled from the records of early Spanish missionaries among the Aztecan Indians; it derived importance from the fact that these records are little known, and have not hitherto been brought to the attention of students of anthropology. The discussion by Dr. Hrdlicka and others indicated that many of the superstitions and ceremonies of the ancient Mexicans are duplicated among the more primitive peoples of different countries, notably those of central Europe.

'The Study of Ceremony,' by Dr. Washington Matthews, followed. The author expressed the conviction that the ceremonies